A GUIDE TO THE ONTARIO AIR QUALITY INDEX SYSTEM

MARCH 1991

Ontario
Environment
Environnement

91-06685/

ISBN 0-7729-8230-9

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Prepared by:

Air Resources Branch
Ontario Ministry of the Environment

MARCH 1991

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log 91-2206-047
PIBS 1472

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ABSTRACT

Since 1988 the Ontario Ministry of the Environment has been operating a Provincial real-time air quality monitoring system-the Air Quality Index (AQI). The AQI system principal objective is to provide the Ontario public with continuous information on ambient concentration levels of 6 common air contaminants: carbon monoxide, suspended particles, total reduced sulphur compounds, nitrogen dioxide, ozone, and sulphur dioxide. The levels of each of the air contaminants are converted to whole numbers on a common scale from which the Air Quality Index is derived. The Index is currently monitored in 27 cities at 34 sites. The Air Pollution Index (API), in operation since 1970 at selected cities, is a sub-index of the AQI and is determined at 25 cities. The API continues to form the basis of a regulatory and alert system. This report provides information on the design and operation of the Air Quality Index system.

1. THE ONTARIO AIR QUALITY INDEX

1.1 Introduction

The Air Quality Index (AQI) is a provincial air quality monitoring and information system that provides the Ontario public with a continuous measure of the quality of the air on a real-time basis (Shenfeld 1987; Shenfeld and Yap, 1989). The Index considers 6 common air contaminants for which there is evidence of adverse effects on health and the environment at specific ambient concentration levels, namely:

Carbon Monoxide (CO)
Suspended Particles[1] (SP)
Total Reduced Sulphur Compounds (TRS)
Nitrogen Dioxide (NO2)
Ozone (O3)
Sulphur Dioxide (SO2)

Additional parameters considered by the Index are the running 8-hour average concentration levels of carbon monoxide (CO(8)), and the Air Pollution Index (see section 2). A description of the 6 air contaminants is given in Table 1.

The Air Quality Index values are reported in whole numbers from zero upwards and increase with deteriorating air quality. The values are divided into 5 descriptive categories (Yap et al., 1989) each of which is a reflection of the possible impacts on health, vegetation, property and aesthetic values (Table 2). The possible health and environmental impacts associated with each air contaminant for each AQI category are presented in Table 3.

The principal objective of the Air Quality Index System is to inform the public on the quality of the air in real-time. Control and regulation of air contaminant emissions are in effect only for local emissions of SO2 and SP as provided by the Air Pollution Index.

The Air Quality Index System was implemented during May-June of 1988 and currently covers 27 cities (Figure 1) with 34 AQI-monitoring sites (Table 4).

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[1] In the AQI system suspended particles (SP) is a term reserved exclusively for denoting fine suspended particulate matter (diameter less than 10 um) in conjunction with its method of monitoring (see Table 1).

1.2 Design and Calculation of the AQI

The Air Quality Index is designed to consider the established air quality objectives and criteria as provided by the Clean Air Act of the Government of Canada and the Environmental Protection Act of the Government of Ontario. These objectives and criteria are designed to protect health and the environment (Table 5). The moderate and poor AQI categories generally correspond to air contaminant concentration levels attaining or exceeding some of the specified objectives and criteria. A summary of the method to determine the value of the Index is indicated in the following paragraph.

Every hour a sub-index is calculated for each of the 8 parameters considered by the Index (Table 6); the value of a given sub-index depends on the ambient concentration level of the corresponding air contaminant. For a given hour, the Air Quality Index is said to be due to the parameter with the highest sub-index and assumes its numerical value.

Sub-indices values for CO, TRS, NO2, O3 and SO2 are calculated based on the respective 1-hour average concentration level. For CO(8), the sub-index is calculated based on the running 8-hour average levels of CO; the SP sub-index is calculated based on 1-hour accumulation of suspended particles. The sub-index value for the Air Pollution Index (API) is the actual value of the API (calculated every hour from a combination of the running 24-hour average concentration levels of each of SO2 and SP).

The relationship between each air contaminant concentration levels and the corresponding sub-index values are given in Figures 2-8.

1.3 Accessing the AQI

The AQI is released to the media (via FACSIMILE) and to the public 8 times daily at 0430, 0630, 0730, 1130, 1430, 1630, 2030 and 2330 local time (LT). The Index is further released every hour if any one of the 34 sites records AQI values of 32 or higher.

The public can access the AQI by various means. Three telephones lines with recorded messages are available 24 hours every day for direct access to the AQI values for all 34 sites. The telephone numbers are:

1) 242-9100 and 235-5781 (Metro Toronto)

2) 1-800-387-7768 (toll free, across the Province)

Also, local newspapers (such as the Toronto Star and the Hamilton Spectator) display the previous day's AQI values at selected sites for specific times; the Television Network Weathernow (available on Cable TV) regularly displays updated AQI values and some television stations display the local AQI values during news broadcasts.

1.4 AQI Forecasts

The AQI system also provides a site-specific air quality forecast for all 34 sites. The forecasts are issued 4 times daily at 0730, 1130, 1430 and 1630 LT with updates as required. The forecast period ranges from the current day (0730 LT release) to the following day (1630 LT release). The public can access the forecasts from the 3 AQI message telephone lines.

The forecasts reflect the probability of occurrence of the meteorological conditions that can contribute to an unacceptable AQI ($\geq$ 32) due to the specified air contaminant at the indicated site. Also provided is the approximate time of occurrence and duration of the unacceptable AQI based on the expected meteorological conditions.

Three descriptive terms are used by the AQI meteorologist to quantify the probability of occurrence of the meteorological conditions that can contribute to an unacceptable AQI.

	% PROBABILITY OF OCCURRENCE
1) Slight Possibility	10-49
2) Possibility	50-74
3) Probable	75-99

An example of an AQI forecast is given in Appendix A.

2. THE ONTARIO AIR POLLUTION INDEX

2.1 Introduction

Before the implementation of the AQI system, the Ministry of the Environment has been operating the Air Pollution Index (API) since 1970 at selected cities. The API was established from a need to monitor the simultaneous occurrence of ambient levels of sulphur dioxide and suspended particles since epidemiological studies associate respiratory illness with elevated ambient levels of these two air contaminants (Shenfeld, 1970).

In an effort to control local emissions of SO2 and SP, the Air Pollution Index was implemented in the Legislature in 1971 under the Province of Ontario Environmental Protection Act, Regulation 308. The Act authorizes the Minister of the Environment to order any source that is not essential to public health or safety to curtail or cease its operation when the Index reaches levels that are considered injurious to health. The Index makes provisions for 5 categories under which a control order for curtailment of industrial operations may be issued (Table 7).

Control orders for industries within a city may first be issued when the API at any one of the API-monitoring sites in the city reaches the Advisory Level *and* adverse meteorological conditions are forecast to persist for at least 6 hours. Further subsequent curtailment of operations is ordered when the API increases category *and* adverse meteorological conditions are forecast to persist for at least 6 more hours.

2.2 Design and Calculation of the API

The API is calculated every hour from a combination of each of the running 24-hour average concentration levels of SO2 and SP. The design of the Index is such that the Advisory Level corresponds either to (1) the simultaneous attainment of the 24-hour average air quality criterion for SO2 (0.10 ppm) and SP (1.0 COH units) or (2) exceedances of either or both of the respective 24-hour average criterion for SO2 and SP. The remaining categories were included as a margin of safety to allow for curtailment action to prevent the occurrence of severe air pollution levels.

The equations to calculate the API are presented in Table 8. A single API equation applicable at all sites is not possible because the current method used to monitor ambient levels of SP on a real-time basis depends on the composition and physical characteristics of the suspended particles, which in turn depend on the local sources of SP. However, the design of the Index ensures that the Index values bear the same significance irrespective of the location.

The API was previously operated in 9 cities. With the advent of the AQI network the number of cities has been increased to 25 with 32 API monitoring sites (Table 4). The API is now one of the 8 sub-indices of the Air Quality Index and continues to form the basis of a regulatory and alert system irrespective of the value of the AQI.

3. THE AQI MONITORING NETWORK

3.1 The AQI Monitoring Network

The AQI monitoring network was implemented during May-June of 1988 at 33 sites across the Province. In November of 1989 Fort Frances was added to the existing network, bringing the total of AQI-monitoring cities to 27 with 34 monitoring sites. The cities were selected based on population, previous air quality history and on the expected potential for elevated air contaminant concentration levels.

Within large urban centres or cities with large industrial complexes, the AQI is generally monitored at more than one site (9 in Metropolitan Toronto, 4 in Hamilton and 2 in Windsor). In some cities the potential of occurrence of elevated ambient concentration levels of a given air contaminant may be considered as being low (this is usually the case when there is no significant local source of that air contaminant); in such cases the air contaminant may not be monitored at the AQI site of that city. This criterion limits the number of air contaminants monitored at each AQI site. A complete list of the 34 AQI sites, identification numbers, names, locations, air contaminants and meteorological parameters monitored at each site is given in Table 9.

In addition to monitoring the AQI, the Ministry of the Environment operates an extensive air quality and meteorological monitoring network comprising over 200 monitoring sites (including the AQI sites) and covering up to 70 cities and communities (Air Quality in Ontario, 1989 Report). The measured air contaminant concentration levels are available from the Ministry of the Environment annual Air Quality in Ontario reports.

3.2 The Telemetry Network System

To continuously monitor air contaminant concentration levels in real-time, the Ontario Ministry of the Environment operates a provincial computerized telemetry network system that logs, transmits and processes air quality and meteorological data from 106 sites across the Province. The system consists of 106 on-site data loggers (D2200 data logger), 6 regional data processing units (CAT8110) and a central main frame computer (VAX 11/780) in Toronto (Fig 9). The system is operated 24 hours per day, every day of the year.

Data from each of the monitoring instruments are collected every 2 seconds by the on-site data logger and transmitted to the regional data processor unit where 5 minute averages are computed and stored. The data are then transmitted to the central computer every hour. The central computer has been programmed to calculate the AQI, the API, various statistical averages and to generate hourly, daily and monthly reports.

The system allows interaction with staff to improve air quality assurance and efficiency. At any time, the staff can interrogate the regional data processing unit and access 5-minute average values. Any required editing of the data is accomplished on the main frame computer.

4. THE METEOROLOGICAL DATA ACQUISITION SYSTEM

To effectively respond to any emergencies that may occur and to provide up to-date AQI forecasts, the Air Quality and Meteorology Section (AQMS) of the Ministry of the Environment operates a real-time weather office every day of the year. The meteorological data required for the operation of the office are collected and processed through the Section's Meteorological Data Acquisition System (MDAS).

MDAS runs on a Data General MV/3500 computer running the AOS/VS II operating system. It consists of a package that is designed to receive and store all relevant meteorological data (observations and prognostics) available from Environment Canada, Atmospheric Environment Service, through the Anikom 100 satellite system. The data are available for immediate analysis in real time, permitting the operation of the weather office.

The multi-role nature of MDAS also assists the Ministry's staff in the performance of numerous other functions, some of which include:

- LIMA (Lambton Industrial Meteorological Alert System) and API forecasts as required
- Long term studies of acidic precipitation in Ontario
- Routine forecasting in support of various Ministry environmental monitoring programmes
- Analysis of citizen air-quality related complaints

MDAS is also linked to the Telemetry Network System main frame computer and allows transfer of current air quality data to the MV for integration with current meteorological data.

5. SUMMARY

Since 1988 the Air Quality Index (AQI) system has been successfully providing the Ontario public with continuous information on the quality of the air in real-time by releasing AQI values at least 8 times every day. Air Quality Index forecasts released 4 times per day and valid up to the following day constantly keep the public informed on any expected changes in AQI values. Though the Index's principal objective is to disseminate air quality information, the inclusion of the Air Pollution Index (API) within the AQI system allows the Ministry of the Environment to continue to control local emissions of sulphur dioxide and suspended particles when adverse API levels occur.

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ACKNOWLEDGEMENTS

The authors would like to thank the staff of the Air Quality and Meteorology Section for their comments on the report and a special thank to Mr. Wilfred Dong for his assistance in the production of the sub-indices graphs.

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CARBON MONOXIDE (CO)

CHARACTERISTICS	:	A colourless, odourless and tasteless gas.
SOURCES	:	Motor-vehicle exhausts account for 80% of the emitted CO. Other sources include fossil fuel combustion for building, heating and commercial and industrial operations.
MONITORING METHOD:		Non-dispersive infrared photometry based on the preferential absorption of infrared radiation by CO.

SUSPENDED PARTICLES (SP)

CHARACTERISTICS	:	Suspended particulate matter with diameter less than 10 microns (fine particles) in solid or liquid form that can reach the lungs. The particles may remain suspended in the air in the form of dust, smoke, fumes, aerosols, soot, mist, etc. The term *suspended particles (SP)* is reserved exclusively for denoting *fine* suspended particulate matter in conjunction with its method of monitoring.
SOURCES	:	Industrial processes which include combustion, incineration, construction, mining, metal smelting, processing and grinding. Also from motor vehicle exhausts. Natural sources include wind-blown soil, forest fires, ocean spray, volcanic activity.
MONITORING METHOD:		Determined by drawing a known volume of air through a portion of a filter tape and then comparing the attenuation of the light transmitted through the particles deposited on the tape with the light transmitted through a clean section of the tape. The light transmittance attenuation is expressed as units of coefficient of haze (COH units), or degree of soiling. The degree of soiling is a relative measure of the ambient concentration of fine suspended particulate matter.

TOTAL REDUCED SULPHUR COMPOUNDS (TRS)

CHARACTERISTICS	:	Odorous sulphur-containing compounds such as hydrogen sulphide (rotten egg odour) and methyl mercaptans (rotten cabbage odour).
SOURCES	:	Steel industry, pulp and paper mills, refineries. Natural sources include swamps, bogs, marshes.
MONITORING METHOD:		Reduced sulphur compounds are oxidised to SO2; the resulting SO2 concentration is then measured using fluorescent excitation by ultraviolet radiation.

TABLE 1: Brief description of the 6 air contaminants considered by the Air Quality Index.

NITROGEN DIOXIDE (NO2)

CHARACTERISTICS	:	A brown gas with a pungent and irritating odour over 0.10 ppm.
SOURCES	:	All combustion processes including vehicle, power plants, heating systems, incinerators, etc.
MONITORING METHOD:		Based on the principle of chemiluminescence involving a gas phase reactions of nitric oxide (NO) with ozone. For NO2, the sample stream is passed through a catalytic converter where NO2 is reduced to NO.

OZONE (O3)

CHARACTERISTICS	:	A pungent colourless gas. Major component of photochemical smog.
SOURCES	:	Ozone is not directly emitted in the atmosphere; in the lower troposphere it is produced in the air from photochemical reactions (requiring sunlight) involving oxides of nitrogen and hydrocarbons that are emitted primarily by anthropogenic sources. Because ozone production requires warm temperatures and sunny conditions, elevated ozone levels in Ontario are usually restricted between the months of May through September. Ozone is capable of travelling long distances before it is removed from the atmosphere and as such is a major manifestation of the long range transport of air pollutants. Low level tropospheric ozone is not to be confused with the naturally occurring "ozone layer". The ozone layer is observed in the stratosphere some 25 km above the surface of the earth.
MONITORING METHOD:		An air sample reacts with ethylene to emit visible light (chemiluminescence) of intensity directly proportional to the ozone concentration. A number of stations still employ fluorescence for ozone detection.

SULPHUR DIOXIDE (SO2)

CHARACTERISTICS	:	A colourless gas with a strong pungent odour over 0.5 ppm.
SOURCES	:	In Ontario, non-ferrous smelters and coal-fired electric generating plant account for 80% of the emitted SO2. The bulk of the rest originates from other industrial sources such as iron ore smelters, petroleum refineries, pulp and paper mills and area sources including residential, commercial and industrial heating.
MONITORING METHOD:		Fluorescent excitation of SO2 by ultraviolet radiation.

CONTINUATION OF TABLE 1

THE AIR QUALITY INDEX CATEGORIES

CATEGORY	RANGE	DESCRIPTION
VERY GOOD	0 -15	Air quality levels that meet long term goals, normally occurring in areas having a pristine environment with no local man-made sources of air contaminants.
GOOD	15-31	Air quality levels that have no known adverse effects on human or animal health and negligible effects on vegetation, property or aesthetic values.
MODERATE	32-49	Air quality levels that have negligible effects on human or animal health but may adversely affect very sensitive vegetation, property or aesthetic values.
POOR	50-99	Air quality levels that may have adverse effects on sensitive members of human or animal population, or may cause significant damage to vegetation, property or aesthetic values.
VERY POOR	$\geq$ 100	Air quality levels that may have adverse effects to the health of large segments of the exposed population.

TABLE 2: The 5 Air Quality Index categories and a general description of the possible health and environmental impacts associated with each category.

CATEGORY	RANGE	CARBON MONOXIDE CO	NITROGEN DIOXIDE NO2	OZONE O3	SULPHUR DIOXIDE SO2	SUSPENDED PARTICLES SP	AIR POLLUTION INDEX API (SO2 AND SP)	TOTAL REDUCED SULPHUR TRS
VERY GOOD	0 -15	NO EFFECTS	NO EFFECTS	NO EFFECTS	NO EFFECTS	NO EFFECTS	NO EFFECTS	NO EFFECTS
GOOD	16-31	NO EFFECTS	SLIGHT ODOUR	INJURIOUS TO SOME VEGETATION SPECIES IN COMBINATION WITH SO2 (4 HOURS)	INJURIOUS TO SOME VEGETATION SPECIES IN COMBINATION WITH O3 (4 HOURS)	NO EFFECTS	NO EFFECTS	SLIGHT ODOURS
MODERATE	32-49	BLOOD CHEMISTRY CHANGES BUT NO DETECTABLE IMPAIRMENT	ODOROUS	INJURIOUS TO MANY VEGETATION SPECIES	INJURIOUS TO SOME SPECIES OF VEGETATION	SOME DECREASE IN VISIBILITY	INJURIOUS TO VEGETATION DUE TO SO2	ODOROUS
POOR	50-99	INCREASED CARDIOVASCULAR SYMPTOMS IN SMOKERS WITH HEART DISEASE	ODOUR AND DISCOLORATION. SOME INCREASE IN BRONCHIAL REACTIVITY IN ASTHMATICS	DECREASING PERFORMANCE BY ATHLETES EXERCISING HEAVILY	ODOROUS. INCREASING VEGETATION DAMAGE	VISIBILITY DECREASED. SOILING EVIDENT	INCREASED SYMPTOMS IN PATIENTS WITH CHRONIC RESPIRATORY DISEASE	EXTREMELY ODOROUS
VERY POOR	$\geq$ 100	INCREASING CARDIOVASCULAR SYMPTOMS IN NON-SMOKERS WITH HEART DISEASE. SOME VISUAL IMPAIRMENT	INCREASING SENSITIVITY OF PATIENTS WITH ASTHMA AND BRONCHITIS	LIGHT EXERCISE PRODUCES RESPIRATORY EFFECTS IN PATIENTS WITH CHRONIC PULMONARY DISEASE	INCREASING SENSITIVITY IN PATIENTS WITH ASTHMA AND BRONCHITIS	INCREASING SENSITIVITY IN PATIENTS WITH ASTHMA AND BRONCHITIS	SIGNIFICANT RESPIRATORY EFFECTS IN PATIENTS WITH ASTHMA AND BRONCHITIS	SENSITIVE INDIVIDUALS MAY SUFFER NAUSEA AND HEADACHES DUE TO SEVERE ODOUR

Table 3: Description of the possible health and environmental impacts associated with each air contaminant for each AQI category.

SITE ID	SITE NAME
31103	TORONTO - DOWNTOWN
31120	TORONTO - WEST
32010	EAST YORK (LEASIDE)
33003	SCARBOROUGH
34020	NORTH YORK - CENTRAL
34025	NORTH YORK - WEST
35003	ETOBICOKE - WEST
35033	ETOBICOKE - SOUTH
36030	YORK
44008	BURLINGTON
44015	OAKVILLE
45025	OSHAWA
46110	MISSISSAUGA
12008	WINDSOR - UNIVERSITY
12016	WINDSOR - COLLEGE
14064	SARNIA
15001	LONDON
26060	KITCHENER
26045	WATERLOO
27056	NIAGARA FALLS
27067	ST. CATHARINES
28028	GUELPH
29000	HAMILTON - DOWNTOWN
29105	HAMILTON - EAST
29114	HAMILTON - MOUNTAIN
29118	HAMILTON - WEST
71068	SAULT STE MARIE
75010	NORTH BAY
77203	SUDBURY
51001	OTTAWA
52020	KINGSTON
56051	CORNWALL
63200	THUNDER BAY
62030	FORT FRANCES

TABLE 4: List of the 34 AQI monitoring sites. The API is monitored at all sites except at Kingston and Fort Frances.

POLLUTANT	AVERAGING TIME-PERIOD	GOVERNMENT OF CANADA AIR QUALITY OBJECTIVES			GOVERNMENT OF ONTARIO AIR QUALITY CRITERIA
		MAXIMUM DESIRABLE LEVEL	MAXIMUM ACCEPTABLE LEVEL	MAXIMUM TOLERABLE LEVEL	
SO2	1 hour	0.17 (ppm)	0.34	-	0.25
	24 hours	0.06	0.11	0.31	0.10
	1 year	0.01	0.02	-	0.02
CO	1 hour	13 (ppm)	30	-	30
	8 hours	5	13	-	13
NO2	1 hour	-	0.21 (ppm)	0.53	0.20
	24 hours	-	0.11	0.16	0.10
O3	1 hour	51 (ppb)	82	153	80
	24 hours	15	25	-	-
	1 year	-	15	-	-
SP	1 hour	-	-	-	-
	24 hours	-	-	-	1.0 (COH units)
	1 year	-	-	-	0.5
TRS COMPOUNDS					
Pulp mills emissions	1 hour	-	-	-	27 (ppb)
Hydrogen sulphide	1 hour	0.7 (ppb)	10.8	-	20
Methyl mercaptans	1 hour	-	-	-	10

DESCRIPTION OF OBJECTIVES/CRITERIA:

Maximum Desirable Level : Provides a basis of measure for an anti-degradation policy.

Maximum Acceptable Level: Provides a basis of measure of the highest level beyond which effects on personal comfort, well being and the environment may become noticeable.

Maximum Tolerable Level : Provides a basis of measure of the highest level beyond which effects may pose a substantial threat to public health. Appropriate abatement action should be undertaken to prevent the exceedance of this level.

Ontario Criteria : Similar definition as the Federal Maximum Acceptable Level.

TABLE 5: Air Quality Objectives and Criteria as respectively provided by The Clean Air Act of the Government of Canada and The Environmental Protection Act of the Government of Ontario. The averaging time-period corresponds to continuous running time-periods. The units of concentration are as is expressed in the first parentheses encountered. The symbol " - " denotes that there currently exists no objective or criterion.

CALCULATION OF AQI SUB-INDICES

The sub-index of air contaminant specie POL with concentration level [POL] is determined by the relationship:

$$\text{SUB-INDEX OF POL} = A + B^{*}[\text{POL}]$$

The values of A and B vary according to the air contaminant specie and concentration level in corresponding AQI category. The units of concentration are as mentioned in the Table below.

VALUES OF A AND B:

AQI CATEGORY	AIR CONTAMINANT	CONCENTRATION RANGE	A	B
VERY GOOD 0 - 15	API	0 - 15	0	1
	CO	0 - 12	0	1.250
	CO(8)	0 - 5	0	3
	SP	0 - 1.0	0	15
	TRS	0 - 5	0	3
	NO2	0 - 10	0	1.500
	O3	0 - 50	0	0.300
	SO2	0 - 16	0	0.938
GOOD 16 - 31	API	16 - 31	0	1
	CO	13 - 22	-5.67	1.670
	CO(8)	6 - 9	-14	5
	SP	1.1 - 1.9	-4.62	18.75
	TRS	6 - 10	-6.50	3.750
	NO2	11 - 20	-2.33	1.667
	O3	51 - 80	-10.37	0.517
	SO2	17 - 25	-15.87	1.875
MODERATE 32 - 49	API	32 - 49	0	1
	CO	23 - 30	-23.86	2.430
	CO(8)	10 - 13	-24.67	5.670
	SP	2.0 - 3.9	14.11	8.95
	TRS	11 - 27	20.31	1.063
	NO2	21 - 25	-57.25	4.250
	O3	81 - 120	-3.30	0.436
	SO2	26 - 34	-23.25	2.125
POOR 50 - 99	API	50 - 99	0	1
	CO	31 - 49	-34.39	2.720
	CO(8)	14 - 17	-178.78	16.330
	SP	4.0 - 5.9	-53.16	25.79
	TRS	28 - 999	48.59	0.050
	NO2	26 - 52	1	1.885
	O3	121 - 199	-26	0.628
	SO2	35 - 199	39.65	0.300
VERY POOR ≥ 100	API	≥ 100	0	1
	CO	≥ 50	0	2
	CO(8)	≥ 18	0	5.550
	SP	≥ 6.0	0	16.67
	TRS	≥ 1000	0	0.100
	NO2	≥ 53	0	1.887
	O3	≥ 200	0	0.500
	SO2	≥ 200	0	0.500

CONCENTRATION UNITS:

API : dimensionless
TRS, O3 : ppb
SO2, NO2 : pphm
CO, CO8 : ppm
SP : COH units

TABLE 6: Determination the 8 AQI sub-indices.

THE AIR POLLUTION INDEX CATEGORIES

API RANGE	CATEGORY	CONTROL ACTION
0 -31	ACCEPTABLE LEVEL	None
32-49	ADVISORY LEVEL	Significant sources may be advised to prepare for curtailment of operations
50-74	FIRST ALERT	Significant sources may be ordered to curtail operations
75-99	SECOND ALERT	Further curtailment of operations may be ordered
$\geq$ 100	AIR POLLUTION EPISODE THRESHOLD LEVEL	All pollution sources not essential to public health or safety may be ordered to cease operations

TABLE 7: The 5 Air Pollution Index categories and the possible control action within each category.

CALCULATION OF THE AIR POLLUTION INDEX (API)

SITE	EQUATION
TORONTO-DOWNTOWN EAST YORK NORTH YORK-CENTRAL NORTH YORK-WEST YORK	API = 3.50(8.70*SP + 123.6*SO2)**0.73
TORONTO-WEST	API = 3.80(7.50*SP + 124.4*SO2)**0.71
SCARBOROUGH	API = 2.38(12.10*SP + 123.4*SO2)**0.81
ETOBICOKE-WEST	API = 2.38(12.2O*SP + 122.0*SO2)**0.81
ETOBICOKE-SOUTH	API = 3.85(7.20*SP + 125.4*SO2)**0.71
BURLINGTON	API = 2.40(13.00*SP + 123.6*SO2)**0.83
OAKVILLE	API = 3.67(8.50*SP + 120.7*SO2)**0.72
OSHAWA	API = 3.50(8.70*SP + 122.7*SO2)**0.73
MISSISSAUGA	API = 2.40(11.50*SP + 129.8*SO2)**0.81
WINDSOR-UNIVERSITY	API = 3.33(8.80*SP + 124.4*SO2)**0.74
WINDSOR-COLLEGE	API = 3.30(8.80*SP + 124.9*SO2)**0.74
SARNIA	API = 2.51(11.40*SP + 123.8*SO2)**0.80
LONDON	API = 2.70(11.30*SP + 124.1*SO2)**0.79
KITCHENER WATERLOO	API = 3.33(9.10*SP + 120.8*SO2)**0.74
HAMILTON-EAST HAMILTON-MOUNTAIN	API = 2.68(11.00*SP + 122.2*SO2)**0.79
ST CATHARINES	API = 2.54(11.50*SP + 125.1*SO2)**0.80
NIAGARA FALLS	API = 2.54(11.70*SP + 123.5*SO2)**0.80
GUELPH	API = 3.33(9.10*SP + 120.8*SO2)**0.74
HAMILTON-DOWNTOWN	API = 1.47(16.40*SP + 122.9*SO2)**0.92
HAMILTON-WEST	API = 2.84(10.80*SP + 120.9*SO2)**0.77
SAULT STE MARIE	API = 3.85(7.70*SP + 124.5*SO2)**0.71
NORTH BAY	API = 4.59(6.30*SP + 120.6*SO2)**0.67
SUDBURY	API = 4.98(5.30*SP + 122.6*SO2)**0.65
OTTAWA	API = 4.59(6.3*SP + 120.6*SO2)**0.67
CORNWALL	API = 3.60(7.80*SP + 125.8*SO2)**0.72
THUNDER BAY	API = 6.19(3.00*SP + 123.2*SO2)**0.60

TABLE 8: Equations to calculate the API. SP and SO2 respectively represent the running 24-hour average concentrations of suspended particles in COH units, and sulphur dioxide in ppm.

SITE ID	SITE NAME	SITE LOCATION	CO	NO2	O3	SO2	SP	TRS	NO	NOX	HC	V1	V2	V3	T1	T2	T3
31103	TORONTO -DOWNTOWN	22 GROSVENOR ST.	M	M	M	M	M		M	M	M						
31120	TORONTO - WEST	PERTH/RUSKIN	M	M	M	M	M		M	M	M	M					
32010	EAST YORK	MILLWOOD/OVERLEA	M	M	M	M	M		M	M							
33003	SCARBOROUGH	LAWRENCE/KENNEDY	M	M	M	M	M		M	M		M	M		M	M	
34020	NORTH YORK-CENTRAL	HENDON/YONGE ST	M	M	M	M	M		M	M							
34025	NORTH YORK-WEST	35 EDGAR AVE	M	M	M	M	M		M	M							
35003	ETOBICOKE-WEST	CENTENNIAL PK.	M	M	M	M	M		M	M	M						
35033	ETOBICOKE-SOUTH	EVANS/ARNOLD AVE	M	M	M	M	M		M	M	M	M	M	M	M		M
36030	YORK	CLEARVIEW HTS/KEELE	M	M	M	M	M		M	M							
44008	BURLINGTON	HWY 2/N SHORE BLVD E	M	M	M	M	M		M	M							
44015	OAKVILLE	BRONTE RD/WOBURN CR	M	M	M	M	M	M	M	M	M	M					
45025	OSHAWA	RITSON RD/OLIVE AVE	M	M	M	M	M		M	M		M					
46110	MISSISSAUGA	QUEENSWAY/HURONTARIO	M	M	M	M	M		M	M							
12008	WINDSOR-UNIVERSITY	467 UNIVERSITY AVE.	M	M	M	M	M		M	M	M						
12016	WINDSOR-COLLEGE	COLLEGE/SOUTH ST.			M	M	M	M									
14064	SARNIA	CENTENNIAL PK/FRONT	M	M	M	M	M	M	M	M							
15001	LONDON	WESTRN FAIR GROUNDS	M	M	M	M	M		M	M							
26045	WATERLOO	WEBER ST/UNIV			M	M	M										
26060	KITCHENER	WEST/HOMEWOOD AVE	M	M	M	M	M		M	M							
27056	NIAGARA FALLS	ALLENDALE AVE.			M	M	M										
27067	ST. CATHARINES	ARGYLE CR.	M	M	M	M	M		M	M							
28028	GUELPH	EXHIBITION/CLARK ST			M	M	M										
29000	HAMILTON-DOWNTOWN	ELGIN/KELLY ST	M	M	M	M	M	M	M	M	M						
29105	HAMILTON-EAST	NASH RD/KENTLEY DR			M	M	M										
29114	HAMILTON-MOUNTAIN	VICKERS RD/E 18TH ST		M	M	M	M	M	M	M							
29118	HAMILTON-WEST	MAIN ST/HWY 403		M	M	M	M	M	M	M							
71068	SAULT STE MARIE	PATRICK/WALLACE ST		M	M	M	M	M		M		M			M		
75010	NORTH BAY	ROSE/CHIPPEWA ST	M	M	M	M	M			M		M			M		
77203	SUDBURY	SCIENCE NORTH	M	M	M	M	M	M		M							
51001	OTTAWA	RIDEAU/WURTEMBURG ST	M	M	M	M	M		M	M							
52020	KINGSTON	CHURCHILL PARK			M												
56051	CORNWALL	MEMORIAL PARK	M	M	M	M	M	M	M	M							
63200	THUNDER BAY	615 JAMES ST S.	M	M	M	M	M	M	M	M		M					
62030	FORT FRANCES	CHURCH STREET						M									

TABLE 9: The 34 AQI monitoring sites and the air contaminants and meteorological parameters monitored (M) at each site. NO = Nitric oxides; NOX = Oxides of nitrogen; HC = Hydrocarbons. V1, V2 , V3 and T1, T2, T3 respectively are the 1st, 2nd and 3rd height-level wind velocity and air temperature.

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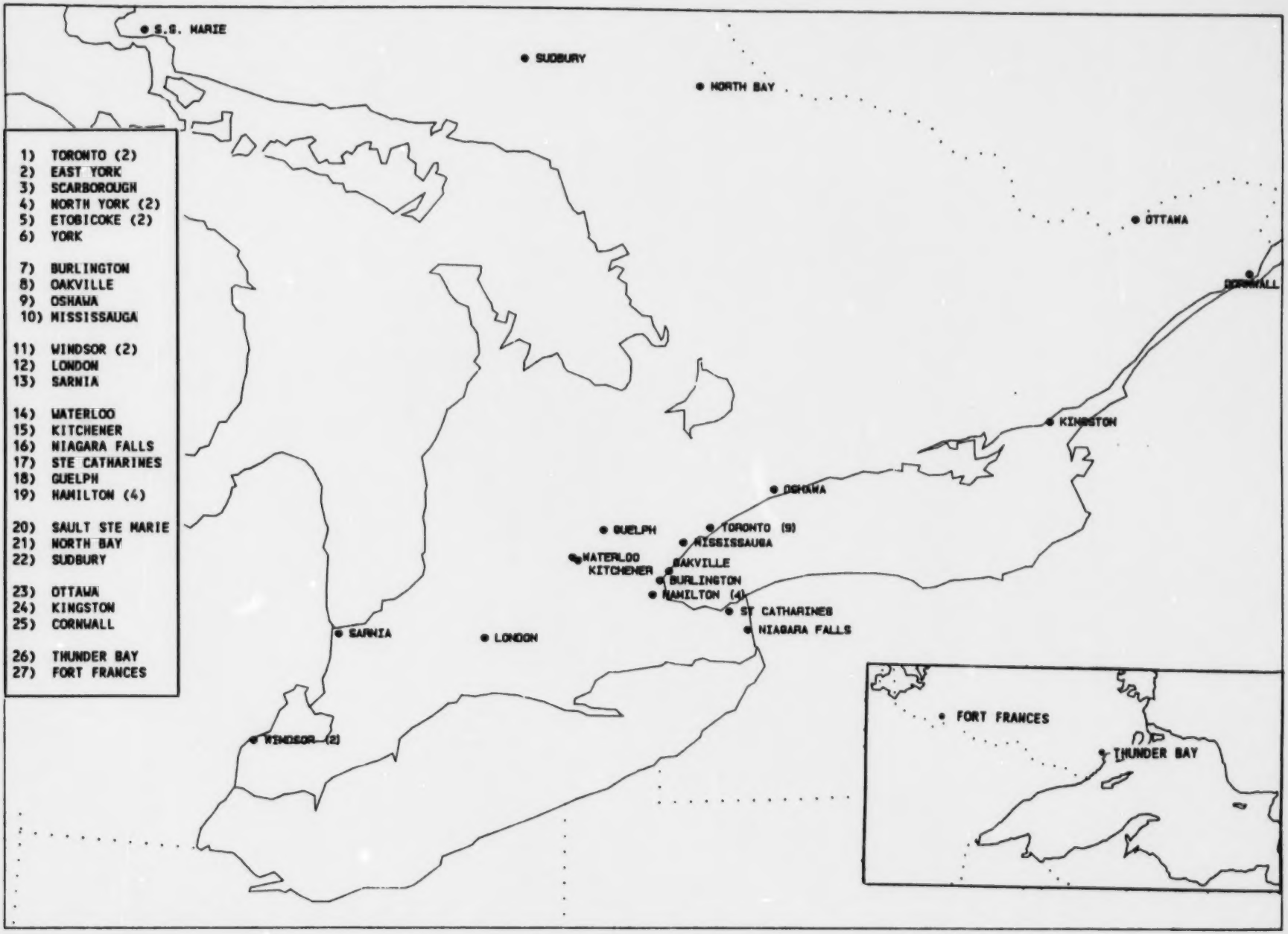
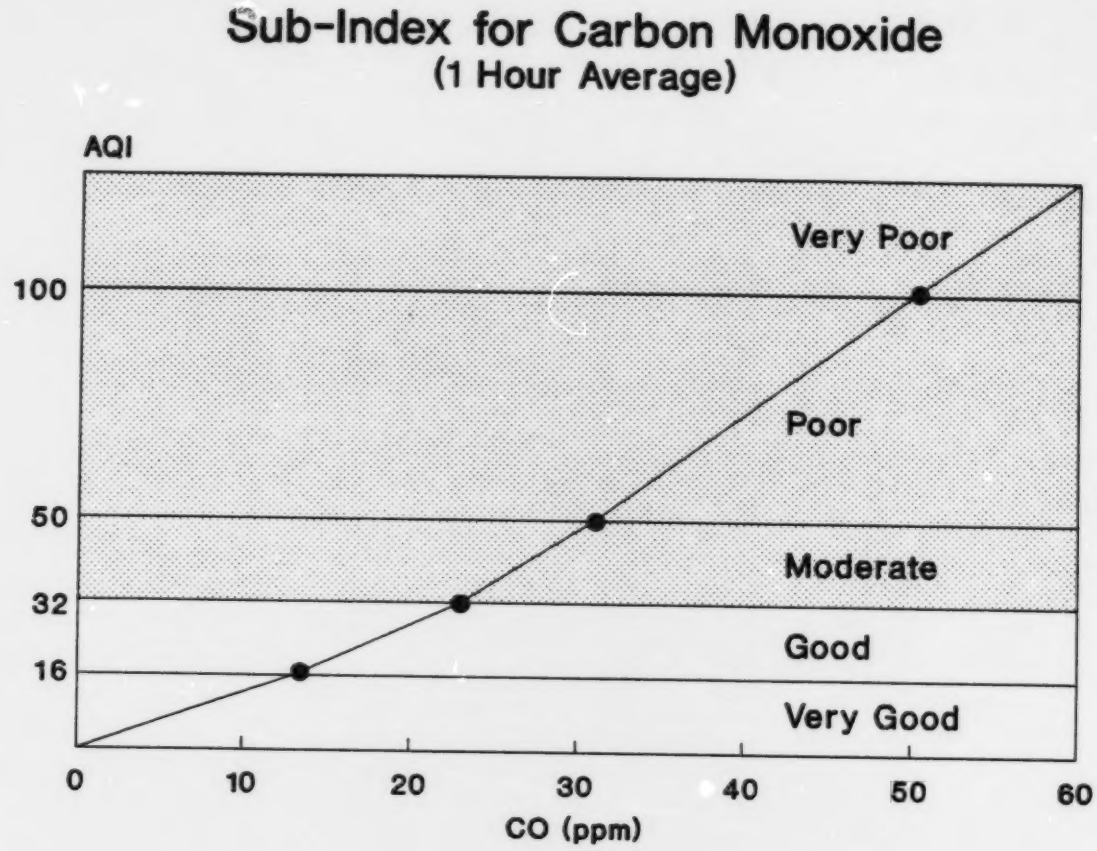
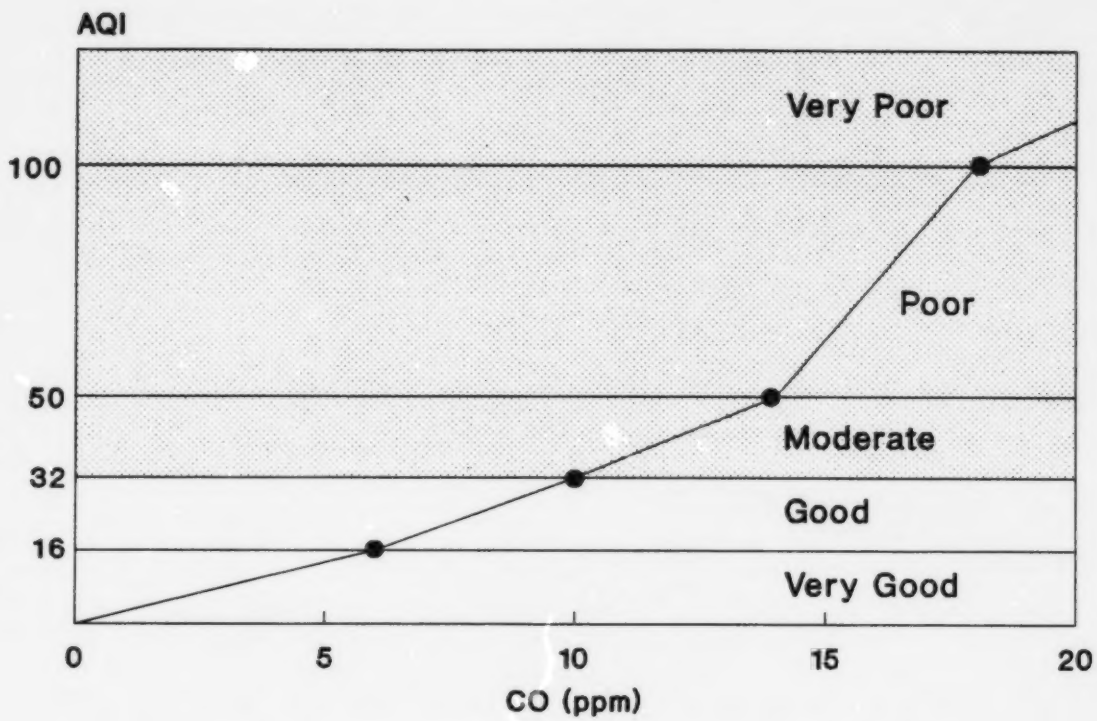


FIGURE 1: The 27 Air Quality Index monitoring cities. The numbers in parentheses are the number of AQI monitoring sites in the city.



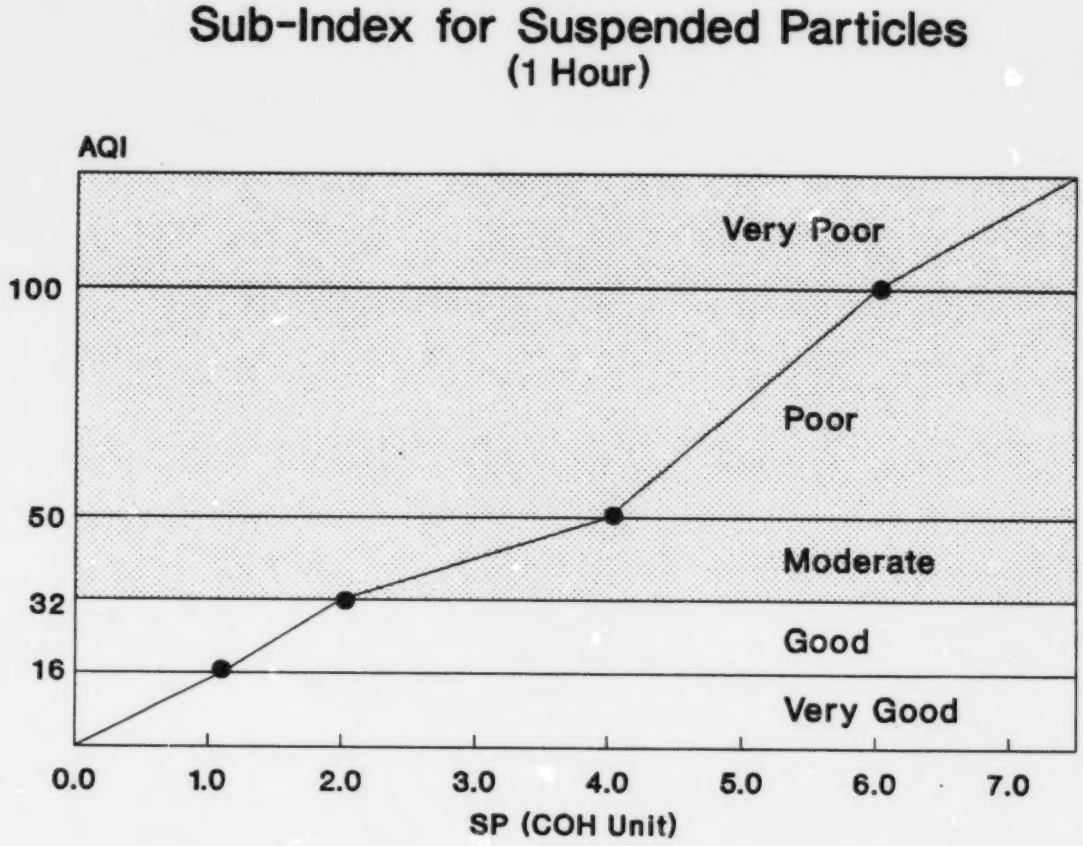
AQI CATEGORY	CONCENTRATION RANGE (ppm)
Very Good	0 - 12
Good	13 - 22
Moderate	23 - 30
Poor	31 - 49
Very Poor	$\geq$ 50

FIGURE 2: Relationship between carbon monoxide 1-hour average concentratrion levels and the CO sub-index values.



AQI CATEGORY	CONCENTRATION RANGE (ppm)
Very Good	0 - 5
Good	6 - 9
Moderate	10 - 13
Poor	14 - 17
Very Poor	$\geq$ 18

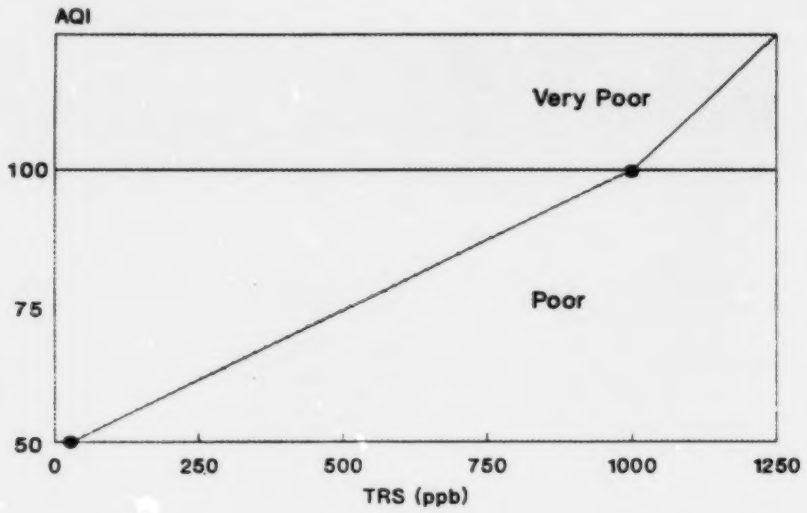
FIGURE 3: Relationship between carbon monoxide 8-hour average concentration levels and the CO(8) sub-index values.

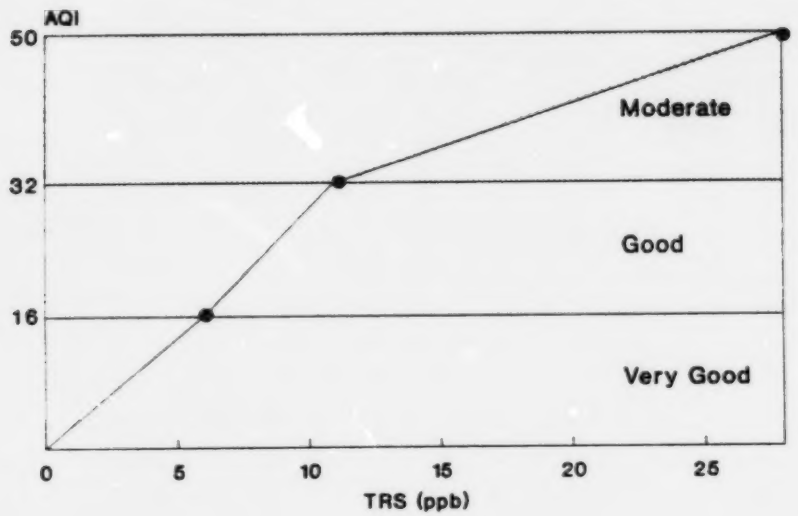


AQI CATEGORY	CONCENTRATION RANGE (COH units)
Very Good	0 - 1.0
Good	1.1 - 1.9
Moderate	2.0 - 3.9
Poor	4.0 - 5.9
Very Poor	$\geq$ 6.0

FIGURE 4: Relationship between suspended particles 1-hour levels and the SP sub-index values.

Sub-Index for TRS
(1 Hour Average)

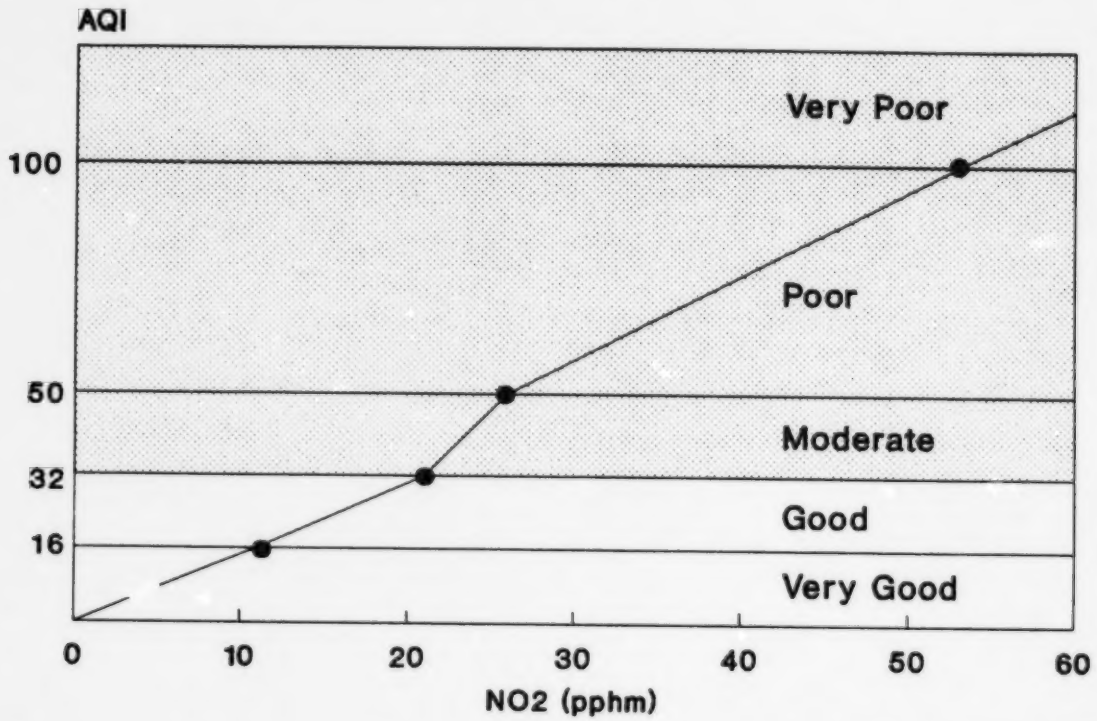




AQI CATEGORY	CONCENTRATION RANGE (ppb)
Very Good	0 - 5
Good	.6 - 10
Moderate	11 - 27
Poor	28 - 999
Very Poor	$\geq$ 1000

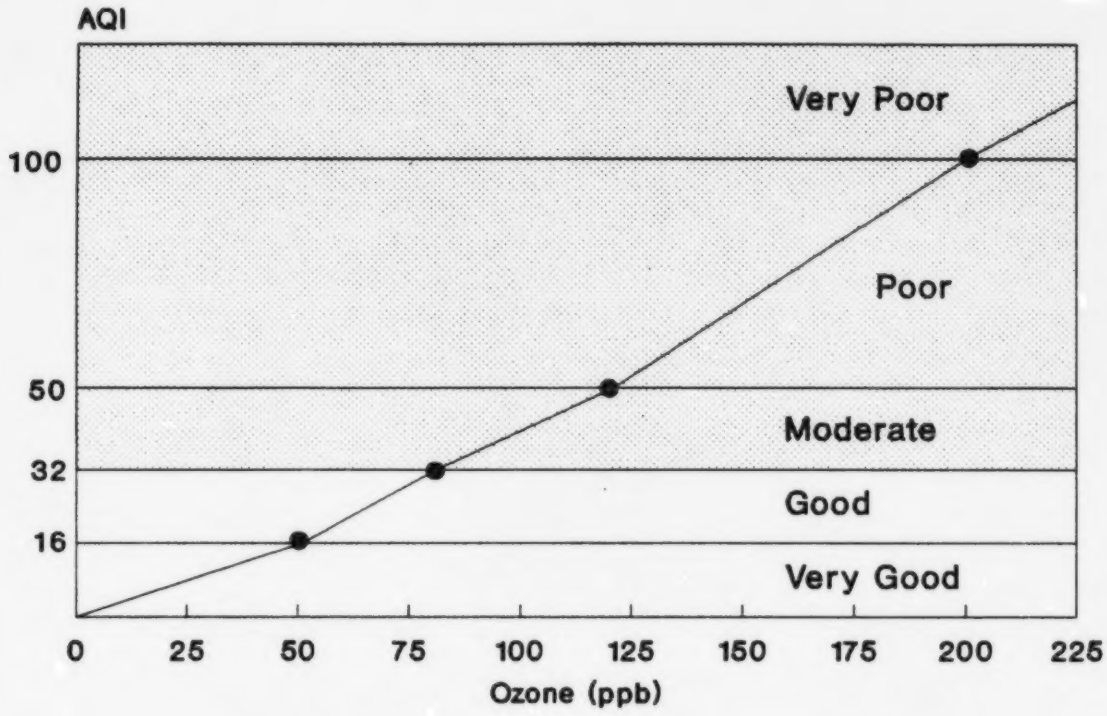
FIGURE 5: Relationship between total reduced sulphur compounds 1-hour average concentration levels and the TRS sub-index values.

Sub-Index for Nitrogen Dioxide
(1 Hour Average)



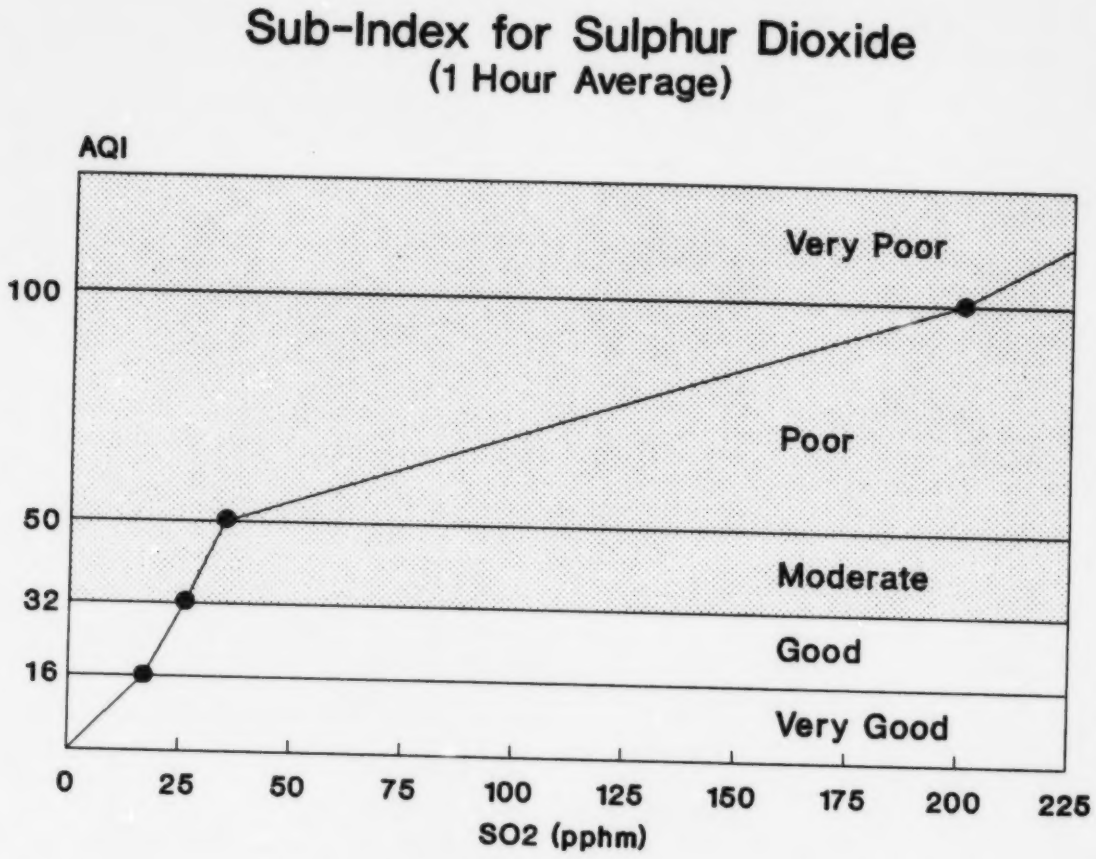
AQI CATEGORY	CONCENTRATION RANGE (pphm)
Very Good	0 - 10
Good	11 - 20
Moderate	21 - 25
Poor	26 - 52
Very Poor	$\geq$ 53

FIGURE 6: Relationship between nitrogen dioxide 1-hour average concentration levels and the NO2 sub-index values.



AQI CATEGORY	CONCENTRATION RANGE (ppb)
Very Good	0 - 50
Good	51 - 80
Moderate	81 - 120
Poor	121 - 199
Very Poor	$\geq$ 200

FIGURE 7: Relationship between ozone 1-hour average concentration levels and the O3 sub-index values.



AQI CATEGORY	CONCENTRATION RANGE (pphm)
Very Good	0 - 16
Good	17 - 25
Moderate	26 - 34
Poor	35 - 199
Very Poor	$\geq$ 200

FIGURE 8: Relationship between sulphur dioxide 1-hour average concentration levels and the SO2 sub-index values.

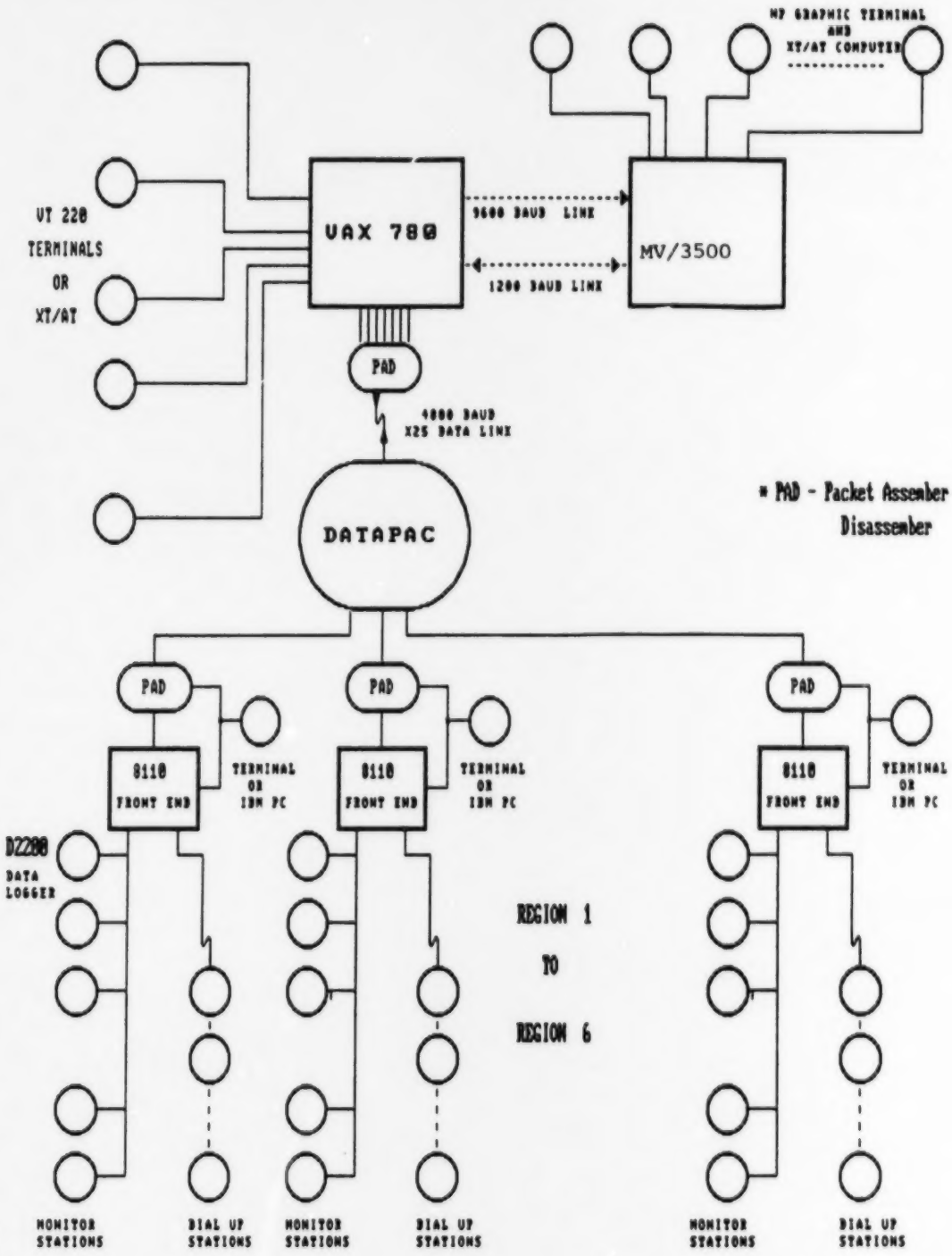


FIGURE 9: Diagram of the telemetry network system and MDAS.

APPENDIX

Example of an Air Quality Index forecast.

ONTARIO MINISTRY OF THE ENVIRONMENT AIR QUALITY INDEX FORECAST ISSUED AT 0730 EDT TUESDAY 07 JULY, 1990 VALID FOR TODAY.

At some sites of southern Ontario...Possibility of moderate AQI due to ozone beginning in the afternoon and ending near mid evening. Otherwise generally very good AQI is expected across the Province.